RECLAMATION STUDY OF PYRITIC TAILINGS USING FLOAT AND GYPSUM AT THE SULLIVAN CONCENTRATOR - KIMBERLEY, B.C.

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May 9, 1985

Subject: Reclamation Study of Pyritic Tailing Using Float and Gypsum at the Sullivan Concentrator.
Your file DSS 05SQ.23440-4-9275

Dear Sir,

Please find enclosed one (1) original and two (2) copies of the final report amended to your needs.

Yours truly

Manager, Sullivan Concentrator

14 pp

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Technical Research

RECLAMATION STUDY OF PYRITIC TAILINGS USING FLOAT AND GYPSUM AT THE SULLIVAN CONCENTRATOR KIMBERLEY, B.C.

FINAL REPORT

BY

COMINCO LTD.

Work on this project was conducted under auspices of the Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources, Canada

DSS FILE NUMBER : O5SQ.23440-4-9275
DSS CONTRACT SERIAL NUMBER : OSQ84-00370
CANMET PROJECT NUMBER :
CANMET SCIENTIFIC AUTHORITY: Dr. N.K. Dave

Date: May, 1985

This report should be cited as
Contract Report No. OSQ84-00370.

OCT 1 1 1985

MICROMEDIA

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SUMMARY

At Cominco's Sullivan concentrator near Kimberley, B.C. more than 60 million tons of acid generating sulphide tailings are retained in ponds covering 900 acres of land. An extremely acid reaction, salinity and adverse physical conditions preclude neutralization by liming as an effective revegetation technique. Covering tailings with a suitable plant growth medium may be the only revegetation alternative for this extremely phytotoxic mill waste.

Float rock and gypsum are industrial wastes available at the concentrator in sufficient quantity to cover the tailings ponds. Preliminary studies have demonstrated that float rock functions effectively preventing the capillary rise of contaminants from tailings into the growth medium and that herbaceous vegetation can sustain growth on gypsum. These studies also demonstrated that vegetation growing on gypsum accumulates elevated concentrations of fluorine often exceeding suggested safe levels for grazing animals.

Gypsum revegetation studies were not conducted on a site having a limited depth of gypsum placed on float rock. Information on the optimum depth of gypsum and cultural practices required to sustain growth of herbaceous and woody species containing fluorine at levels safe for grazing animals has yet to be developed. To facilitate research on these and other important

subjects related to the use of gypsum and float rock for revegetation of acid generating tailings, a 1.63 acre experimental site was constructed during October-November 1984. A 24" to 36" layer of float rock was spread over imperfectly drained oxidized tailings. Gypsum was placed on the float rock at two depths, 18" and 36". Agricultural grade hydrated lime was incorporated with the gypsum at the equivalent of 10 ton $CaCO_3$/acre to neutralize residual acid compounds in the gypsum in preparation for establishing vegetation in May 1985.

RÉSUMÉ

A le concentrateur de Cominco à Kimberley, C.B. en plus de 60 millions de tonnes de résidu sulfuré formant l'acide sont retenues dans des étang qui couvre de 900 acres de terre. Une très haute réaction acidique, la salinité et des conditions adverse physique empêche la neutralisation avec la chaux comme technique qui serait effective pour la révégetation. Ça serait possible que le seul moyen de faire un bon terrain pour la cultivation des plantes sur ce très phytotoxique résidu de moulin est de le recouvrir d'un sol convenable.

La roche résidu du moulin et le gypse sont des décharges du concentrateur en quantité suffisant pour recouvrir les étangs de résidu. Les études preliminaires ont démontrer que la roche résidu du moulin est effectif pour empêcher la monte capillaire

de contaminants de le résidu dans le sol a végétation et que le gypse peut soutenir la végétation herbacé. Ces études ont aussi démontrer que les végétations qui poussent sur le gypse augmente leurs concentrations de fluorène souvent a des niveau plus hauts qui est considéré sauf pour le bétail qui broute.

Des études de révégétation sur le gypse n'ont pas été faites sur des places de épaisseur limité de gypse sur la roche résidu du moulin. Les données pour la meilleur épaisseur de gypse et les coutumes de cultivation nécessaire pour soutenir la croissance des plantes herbace et boiseux qui contiennent la fluorène a un niveau sauf pour le bétaille qui broute doit être développé. Pour avancer la recherche sur ceux-ci et d'autres suvets importants ayant rapport a l'usage du gypse et de la roche résidu du moulin pour la révégétation sur des residus acidifiants un terrain expérimentale de 1,63 acre a été construit pendant Octobre-Novembre 1984. Une couche de 24 a 36 pouces de roche résidu du moulin a été étendu sur le résidu oxyde qui n'est pas bien égoutter. Le gypse a été étenou sur la roche a deux épaisseurs, 18 et 36 pouces. De la chaux éteinte pour engrais a été mélangé avec le gypse pour appliquer dix tonnes de $CaCO_3$ à l'acre pour neutralisé les composés acidiques qui restent dans le gypse pour préparer pour la révégétation pendant le mois de Mai 1985.

Reclamation Study of Pyritic Tailings Using Float and Gypsum at the Sullivan Concentrator, Kimberley, B.C.

1. Introduction

An experimental site was constructed to facilitate research for the development of reclamation technology for acid generating iron sulphide tailings using industrial wastes. The project was a joint venture between Cominco Ltd., Sullivan Concentrator, Kimberley, B.C. and CANMET, Division of Energy, Mines and Resources Canada. Cominco was responsible for planning, supervision and construction of the proposed experimental site. CANMET agreed to share equally with Cominco, the cost of construction. This report describes the background and objectives of the project, the construction of the experimental site and briefly discusses revegetation studies which are planned for establishment on the site during the 1985 growing season.

2. Background and Objective

The Sullivan Concentrator has been operational since 1923 producing lead and zinc concentrates along with over 60 million tons of acid generating sulphide tailings. The tailings are stored in large retaining ponds covering more than 900 acres of land. Two types of tailings are produced and are referred to as siliceous and iron tailings. Iron tailings are approximately 85%

pyrrhotite and cover 570 acres. Siliceous tailings contain 20% pyrrhotite and cover 350 acres.

When abandoned, the iron tailings deposit will have large areas of oxidized as well as actively oxidizing tailings on the surface. An extremely high lime requirement, salinity and adverse physical properties essentially preclude liming as an effective reclamation technique for iron tailings. Covering iron tailings with a suitable plant growth medium may be the only revegetation alternative for this extremely phytotoxic mill waste. Investigations are, therefore, being directed toward development of the most practical method of covering iron tailings using a plant growth medium capable of sustaining vegetation which achieves revegetation objectives.

Float rock and gypsum are industrial wastes stored near the tailing ponds. There are sufficient quantities of both materials to cover the iron and, if necessary, siliceous tailings disposal areas. The float rock would be placed in contact with the tailings to prevent migration of contaminants from the tailings into the growth medium. Float rock also provides a stable surface for equipment placing and spreading the growth medium. Gypsum is a waste product of phosphoric acid production and is stored in a pond abutting the iron tailing pond. Gypsum would be spread at an appropriate depth over the float rock, functioning as the plant growth medium. The availability of large quantities of gypsum in close proximity to the iron pond provides

significant cost advantages over the use of soil or overburden for this purpose. In addition, it is currently not known if sufficient quantities of overburden materials are available within a practical hauling distance of the tailing ponds.

Preliminary studies have demonstrated that float rock functions effectively preventing the capillary rise of contaminants from tailings into the growth medium and that herbaceous vegetation can sustain growth on gypsum. In a study initiated in October 1978, glacial till overburden was placed at thicknesses of 12,24 and 48 inches directly on iron tailings and on a 12 to 18 inch layer of float rock which had been placed on iron tailings. A grass-legume mixture was seeded on the overburden in April 1979. Evidence of overburden contamination was observed during 1980, when the 12 inch layer of overburden in direct contact with iron tailings developed dark staining, a lower pH (3.2) and a higher ECe (6.4 mmhos/cm) relative to overburden in contact with float rock, i.e. pH 5.1 and ECe 0.9 mmhos/cm. By 1983, the fifth growing season, vegetation on 12 inches of overburden in direct contact with iron tailings had completely died out while, in contrast, vegetation on 12 inches of overburden covering float rock continued to sustain satisfactory growth.

Field studies have been in progress since 1976 to assess suitability of gypsum as a growth medium for plants. In summary birdsfoot trefoil, creeping red fescue, hard fescue, crested

wheatgrass, western wheatgrass and woody species trembling aspen, willow, silver maple, white spruce and poplar have sustained growth for up to nine growing seasons on gypsum. On gypsum treated with adequate lime, dense stands of birdsfoot trefoil and crested wheatgrass have sustained satisfactory growth for six growing seasons without maintenance fertilizer. These studies have also demonstrated that vegetation growing on gypsum accumulates elevated concentrations of fluorine, often exceeding suggested safe levels for cattle and horses, i.e. 50 and 60 ppm F, respectively. Fluorine concentrations in vegetation varied widely both within and among plant species and were affected by lime source and resultant gypsum pH. Hard fescue growing on gypsum limed with hydrated lime averaged 59 ppm F, similar to or lower than concentrations in native grasses growing on natural soils adjacent the gypsum experimental area. Native grasses needlegrass, idaho fescue, pinegrass and western wheatgrass averaged 12, 55, 88 and 247 ppm F, respectively. Wheatgrass growing on gypsum limed with hydrated lime averaged as follows: crested wheatgrass 127 ppm F, tall wheatgrass 126 ppm F, western wheatgrass 148 ppm F. Fluorine concentrations in birdsfoot trefoil were higher than those of the grasses. Trefoil plants growing on gypsum limed to pH6 with a mixture of dolomitic limestone and hydrated lime contained 210 ppm F. On gypsum limed to pH 4.9 birdsfoot trefoil accumulated 485 ppm F.

To this point in time gypsum revegetation studies have not been conducted on a site having a limited depth of gypsum placed on

float rock. As a result, information on the optimum depth of gypsum required to sustain growth of herbaceous and woody species has yet to be developed. Soluble fluoride compounds may also leach from gypsum collecting in surface water draining through the float rock layer. The resultant concentration of fluorine in drainage and the possible effect of fluorine on effluent treatment also require investigation. For research on these and other important subjects related to the use of gypsum and float rock for reclamation of iron tailings to proceed, it would be necessary to construct an experimental site which simulates this potential reclamation technique. The objective of this project was to construct such a site.

3. Progress

A 1.63 acre experimental area was constructed during the period 22 October and 6 November, 1984. The plot was situated on imperfectly drained, oxidized iron tailings located between an old tailing dyke and an access road traversing the southwest corner of the iron tailing disposal area (Figure 1). Tailings are saturated with water during part of the growing season. It was necessary to reduce the size of the plot from the planned 2.5 acres to ensure sufficient area remained to accommodate planned buttressing of the dyke.

During the period 22 to 26 October, 1984, 7776 cubic yards of

float rock were hauled, placed and spread over iron tailings in a layer varying in thickness from 24" to 36". Because a greater than planned thickness of float rock was required to provide a stable working surface, actual quantities of float rock applied exceeded plan amount by 776 cubic yards.

Between 29 October and 6 November, 1984, 7872 cubic yards of gypsum was hauled, placed and spread in two thicknesses, i.e. 18" over 0.80 acres and 36" over the remaining 0.83 acres (Figure 2). Because the plot was reduced from plan size, the amount of gypsum used to cover float rock was 1228 cubic yards less than planned.

Residual acid compounds in gypsum must be neutralized before vegetation will establish. In preparation for planting both herbaceous and woody plants on gypsum in 1985, agricultural grade hydrated lime was spread on the plot at a rate equivalent to 10 ton $CaCO_3$/acre. The liming material was applied on 9 and 10 November, 1984. Because the gypsum surface was frozen it was necessary to postpone incorporation of lime to April 1985.

4. Planned Studies

The reclamation objective at the Sullivan Concentrator is to stabilize and rehabilitate waste disposal and other disturbed land areas, wherever possible, by re-establishing a self-sustaining plant community of similar composition, productivity and usefulness as existed before disturbance or as exists on

adjacent land. Undisturbed land near the concentrator has best physical capability for native range and currently sustains an open coniferous forest dominated by Ponderosa pine with significant Douglas fir and trembling aspen with a ground cover of grass and shrub species. In addition to providing forage, protection and shelter for domestic animals and wildlife, vegetation established on the tailings disposal area will minimize the volume of contaminated effluent requiring treatment.

With these objectives in mind, revegetation studies have been planned for establishment on the experimental site in 1985. The purpose of this initial group of studies is to assess the effect of gypsum depth and liming rate on establishment, growth and fluorine uptake by climatically adapted legume, grass, shrub and tree species. Legume and grass species were selected for cold and drought tolerance. Tree and shrub species selected are indigenous to the Kimberley area and planting stock is being propagated from seed collected in the region.

Legume and grass species will be seeded in the spring using a brillion seeder. Fertilizer will be applied prior to seeding to provide nitrogen phosphorous, potassium and magnesium. Tree and shrub seedlings will be planted in the fall.

Available information on the chemical and physical properties of gypsum will be reviewed and deficiencies will be corrected by

appropriate sampling and analysis. Similarly data on fluorine concentrations in vegetation growing on the current gypsum experimental site will be summarized. Literature on fluoride uptake and accumulation by vegetation, potentially hazardous levels of fluorine in vegetation for domestic animals and wildlife as well as on cultural techniques for minimizing fluorine uptake will be reviewed.

Seepage and drainage waters will be sampled periodically and analyzed for phosphorous and fluorine and the potential impact of these contaminants on the effluent treatment process will be investigated.

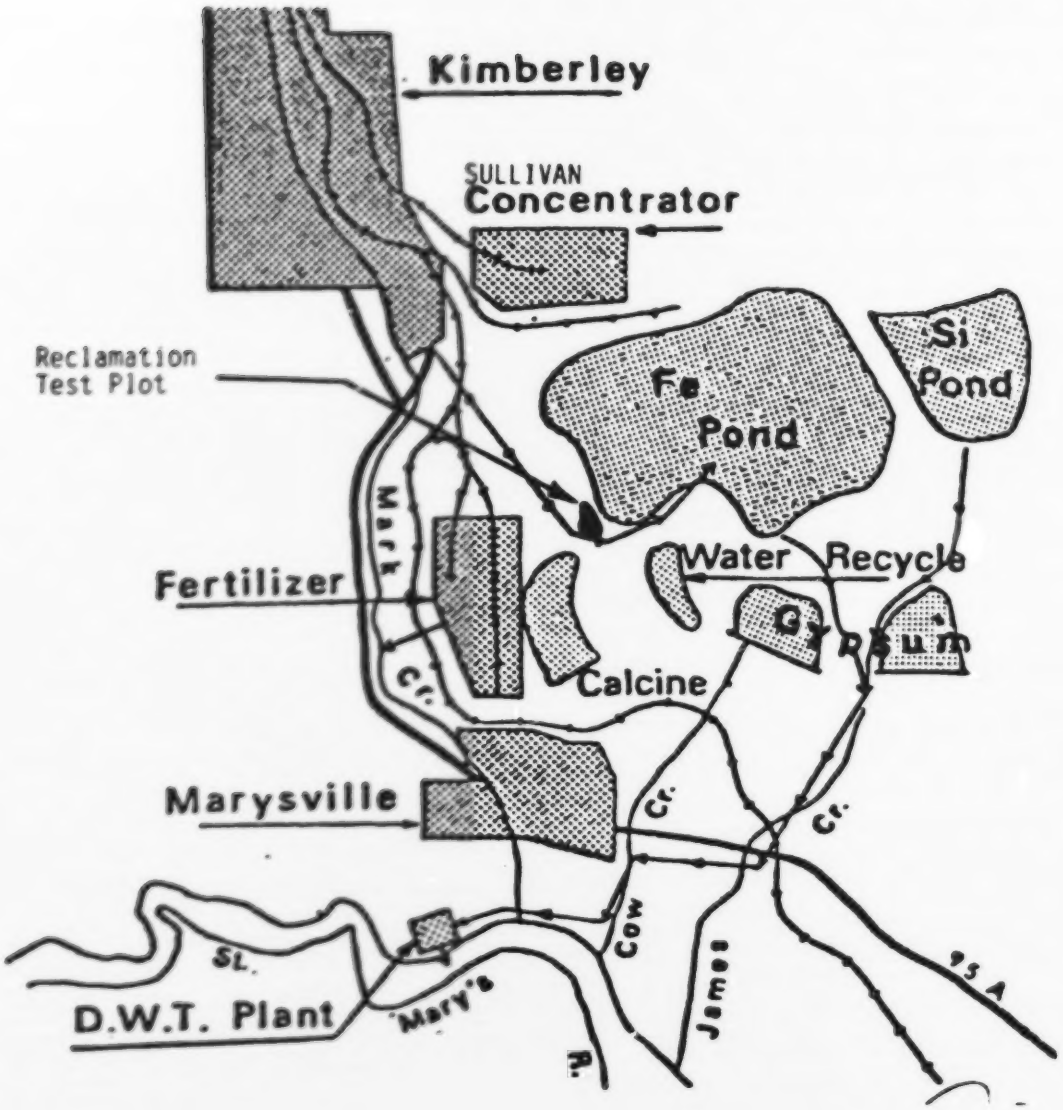

Figure 1: Location of Gypsum / Float Rock Experimental Site in Relation to Tailings and Gypsum Disposal Areas

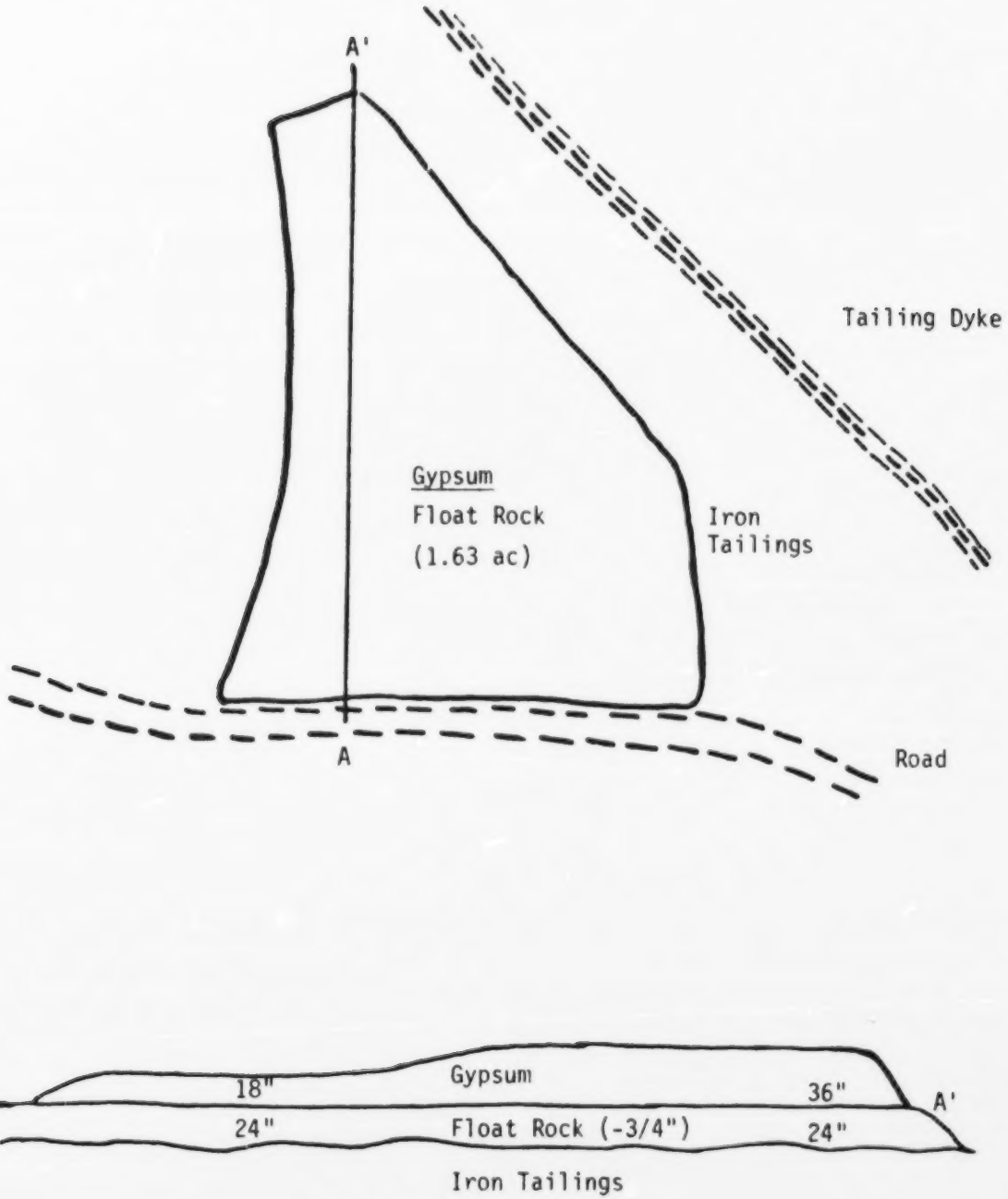

Figure 2: Gypsum / Float Rock Experimental Site on Iron Tailings